IIT ROORKEE

NPTEL ONLINE CERTIFICATION COURSE

Microelectronics: Devices to Circuits

General Feedback Structure and Properties of negative Feedback

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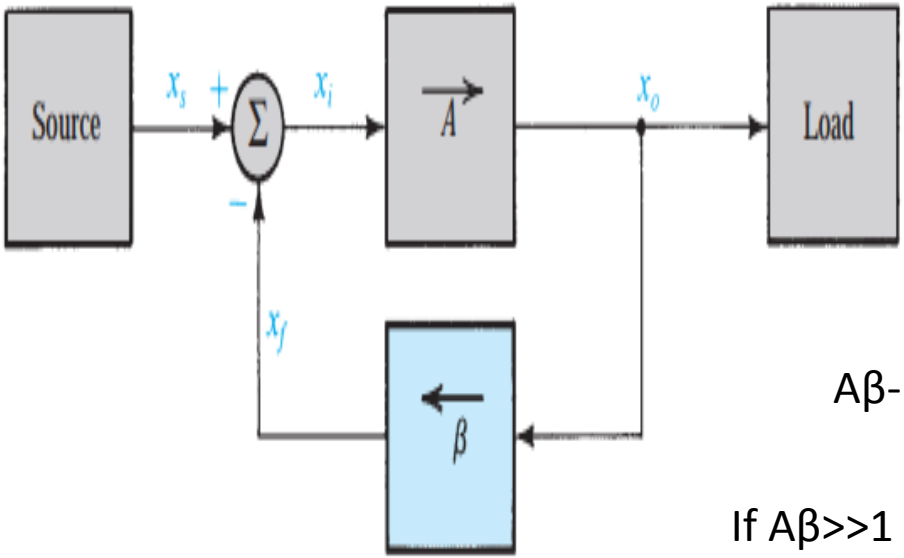
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING



Outline

- General Feedback Structure
- Properties of Negative feedback
- Recapitulation

General Feedback Structure



$$X_0 = A X_i$$

A- Open loop gain

$$X_f = \beta X_0$$

β- feedback factor

$$X_i = X_S - X_f$$

Aβ- loop gain

If Aβ>>1 than $A_f = \frac{1}{\beta}$

$$A_f = \frac{X_0}{X_S} = \frac{A}{1 + A\beta}$$

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Properties of Negative feedback

Gain Desensitivity:

❑The negative feedback desensitize the closed-loop gain by the factor 1+Aβ.

$$A_f = \frac{X_0}{X_S} = \frac{A}{1+A\beta}$$

Assume β is constant and differentiate both side

$$d\,A_f = \frac{dA}{(1+A\beta)^2}$$

$$\frac{d\,A_f}{A_f} = \frac{1}{1+A\beta}\frac{dA}{A}$$

Desensitivity factor (1+Aβ)

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Bandwidth Extension:

- Bandwidth increased by the factor (1+Aβ).

$$A(S) = \frac{A_M}{1 + \frac{S}{w_H}} \qquad A_f(S) = \frac{A(S)}{1 + \beta A(S)}$$

A_M Mid-band gain

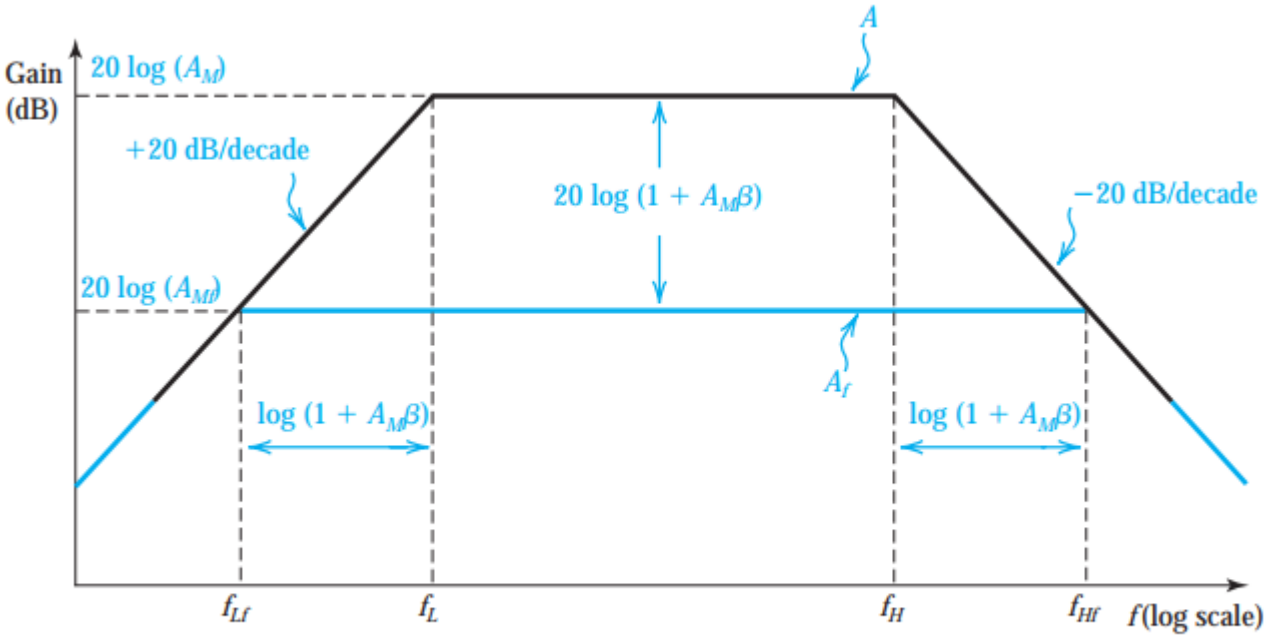
w_H Upper 3-dB frequency

$$A_f(S) = \frac{A_M / (1 + A_M \beta)}{1 + \frac{S}{w_H (1 + A_M \beta)}}$$

Mid-band gain $\frac{A_M}{1 + A_M \beta}$

$$w_{Hf} = w_H (1 + A_M \beta) \qquad w_{Lf} = \frac{w_L}{1 + A_M \beta}$$

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition



$$f_{Lf} = \frac{f_L}{1 + A_M\beta} \qquad A_{Mf} = \frac{A_M}{1 + A_M\beta} \qquad f_{Hf} = f_H(1 + A_M\beta)$$

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Interference Reduction:

- Negative feedback can be employed to reduce the interference in an amplifier or, more precisely , to increase the ratio of signal to interference.

$$\frac{S}{I} = \frac{V_S}{V_n}$$

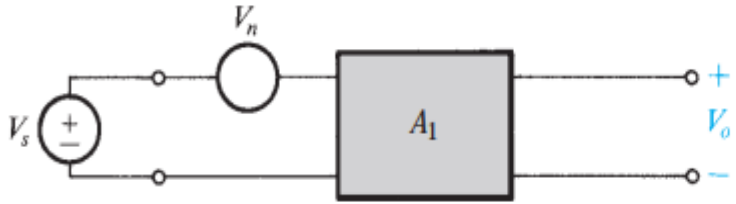
Input signal V_s

Interference V_n

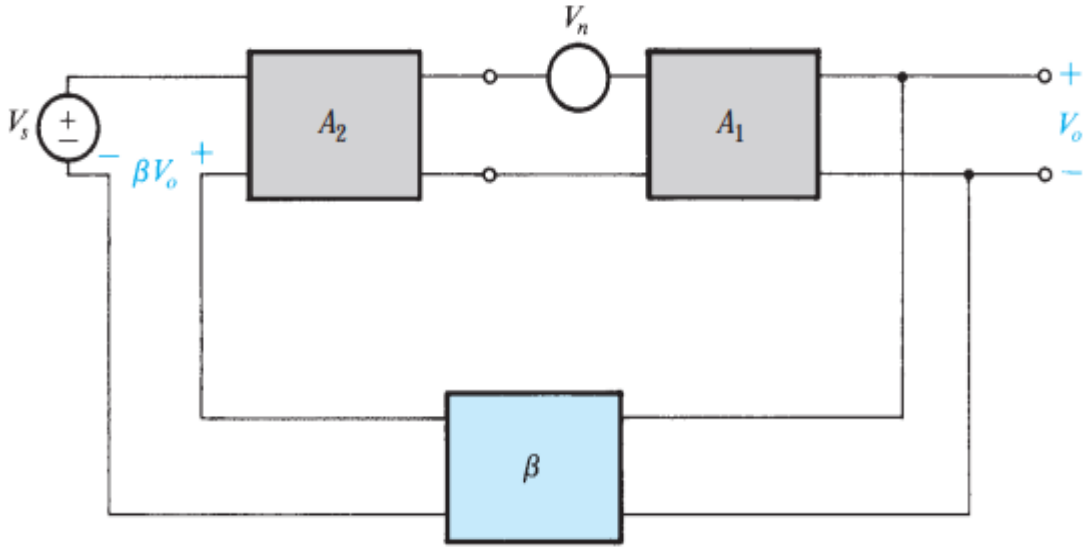
$$\frac{S}{I} = \frac{V_S}{V_n} A_2$$

$$V_0 = V_S \frac{A_1 A_2}{1 + A_1 A_2 \beta} + V_n \frac{A_1}{1 + A_1 A_2 \beta}$$

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition



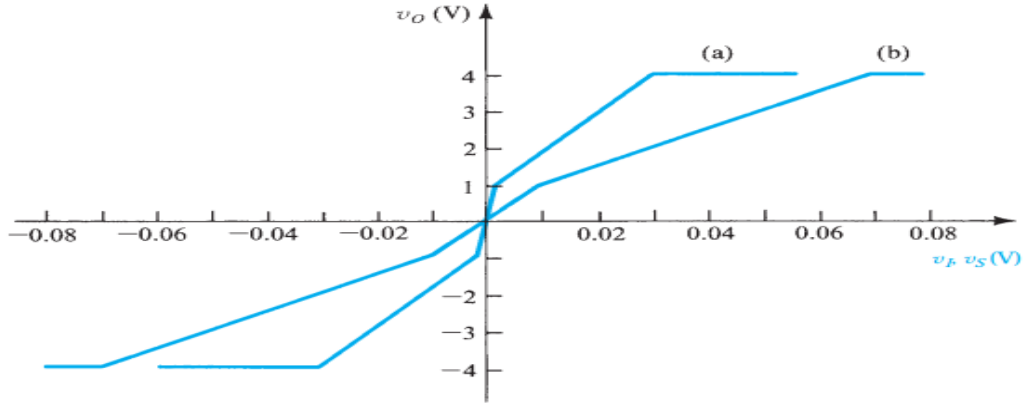
(a)



Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Reduction in Nonlinear Distortion:

- This nonlinear transfer characteristic will result in this amplifier generating a large amount of nonlinear distortion.
- The amplifier transfer characteristic can be considerably linearized (i.e., made less nonlinear) through the application of negative feedback.



Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Recapitulation

- *Desensitize the gain:* that is, make the value of the gain less sensitive to variations in the values of circuit components, such as might be caused by changes in temperature.
- *Reduce nonlinear distortion:* that is, make the output proportional to the input (in other words, make the gain constant, independent of signal level).
- *Reduce the effect of noise:* that is, minimize the contribution to the output of unwanted electric signals generated, either by the circuit components themselves, or by extraneous interference.

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

- *Control the input and output resistances:* that is, raise or lower the input and output resistances by the selection of an appropriate feedback topology.
- *Extend the bandwidth* of the amplifier

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Thank You